Space Weather Technical Forecast

Issued on Thursday, 09 March 2023 at 12:47 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2/Minor-Moderate radio blackouts) likely throughout. Active Electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with an M1.4 flare observed at 08/2245 UTC, which originated from AR3245. There currently nine numbered sunspot regions on the visible disc, and three new small and weak regions which have rotated onto the east limb. AR3242 (Esi/Beta-gamma) in the northwest continues to elongate as it rotates across the disc and has lost its previous delta spot. In contrast AR3245 (Dki/Beta-gamma) had developed a delta spot in the southern portion of its large penumbral leading spot, but this has now separated. The remaining numbered regions are all relatively simple and weak, and mostly stable or showing slight growth. A CME was seen lifting off the northwest late on the 8th March, although this appears to be far-sided and unlikely to have any Earth-directed component, although analysis is on-going. No Earth directed CMEs were observed in available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR and ACE at L1, has been indicative of a waning High Speed Stream (HSS) from CH81. Solar wind data also shows evidence of a possible glancing blow from a weak CME (which left the Sun on March 6th), arriving at 08/0350 UTC. Wind speeds have remained at slightly elevated levels, generally between 410-480 km/s. Density has been around average, with a slight trend upwards due to the arrival of a weak CME, peaking at around 10 ppcc. Total IMF, Bt, generally weak, but became moderate, peaking at 8 nT between 09/0400-1000 UTC, due to glancing blow from a weak CME, with the north-component, Bz, varying weak to moderate, between +8 and -8 nT. Phi angle was primarily negative (towards the Sun), with a period of positive orientation (away from the Sun) between 09/0500-0700 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1 to 3), with an Active interval observed at 09/0600-0900 UTC due to glancing blow from a weak CME, which has now passed.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at background levels. Electron flux at GOES16 has been mostly high with a peak of 4293 pfu at 08/1630 UTC. Electron fluence has been above the Active threshold (1e8 integrated flux) throughout, with a value of 1.97e8 integrated pfu recorded at 09/0001 UTC and a generally slightly increasing trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be mainly Low to Moderate, with a slight chance of High activity. The main risk of flares is from AR3242 and AR3245. During the forecast period active new or returning regions are expected to rotate onto the visible disc from the far side.
Solar Wind / Geomagnetic Activity: The HSS from CH81 is expected to continue to wane through the period, with slightly elevated winds gradually declining to background levels, although this may take a few days as a weak influence from small coronal hole 83 near the

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northern crown may arrive day 1 or day 2 (9-10th Mar). Geomagnetic activity is expected to be mostly Quiet to Unsettled (Kp 1-3), throughout the period, with a chance of Active (Kp 4) intervals today or tomorrow.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is currently at background levels but with a slight chance of reaching S1 or greater should any larger flares occur. Electron flux has recently been at high levels, but was briefly suppressed by the passing of a weak glancing blow from a CME early on day 1 (09 Mar), but is likely to return to high levels at diurnal max. Electron fluence is above the Active (1e8 integrated pfu) threshold and is likely to remain so through the period, albeit with some uncertainty.

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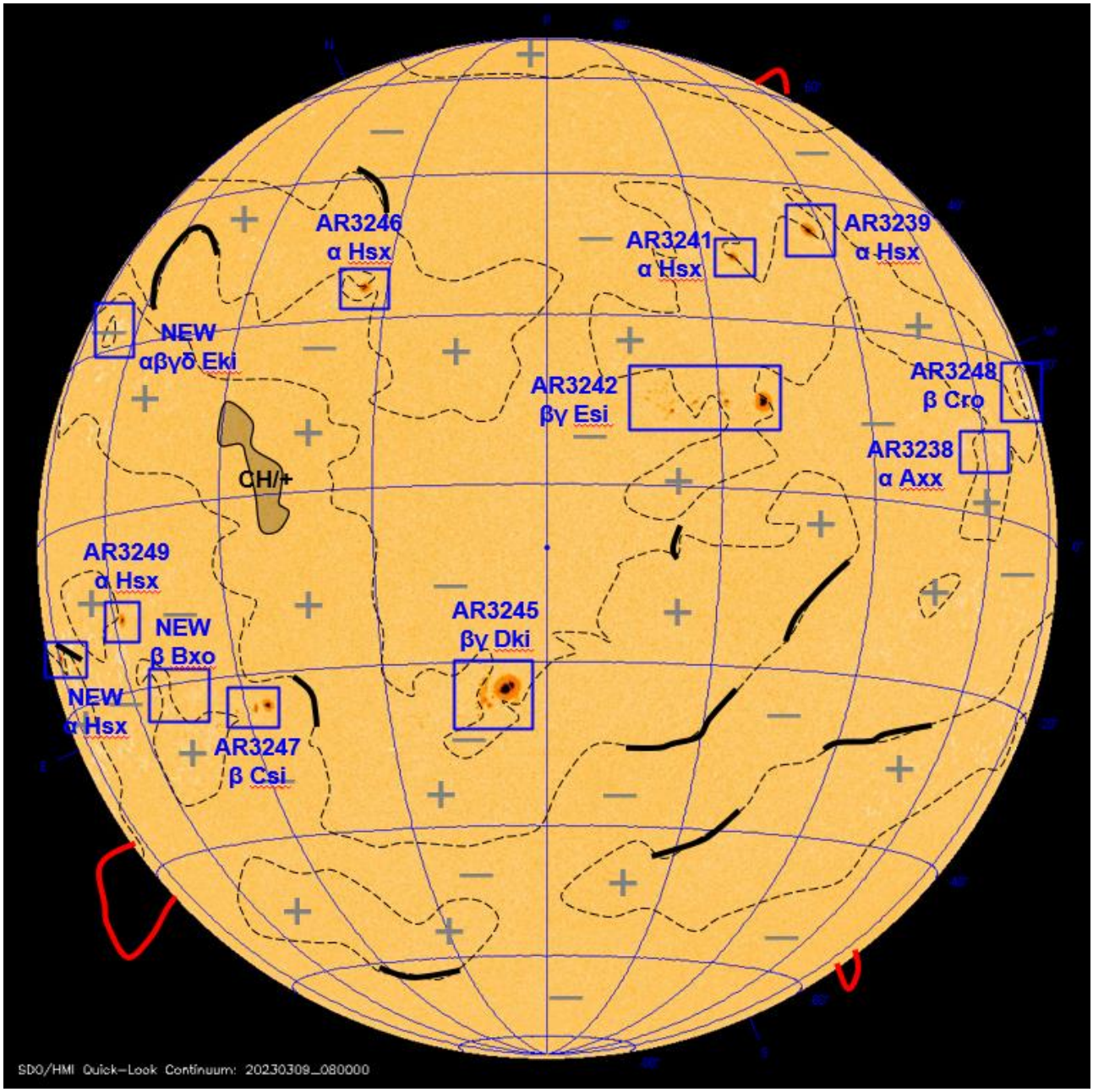
Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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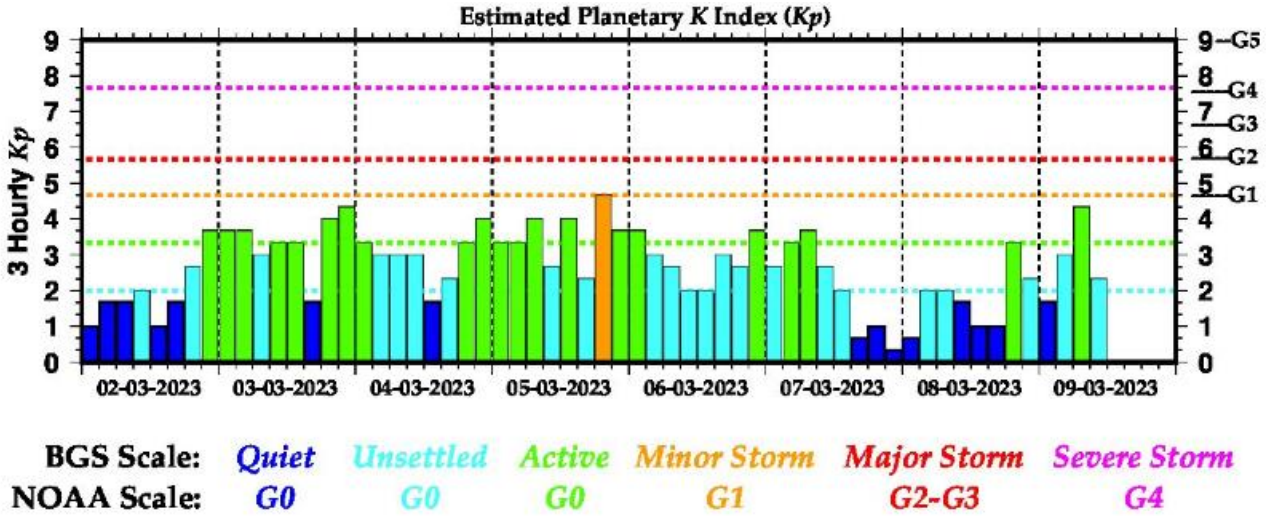
Geomagnetic Storms:

The HSS from CH81 is expected to continue to wane through the period, with slightly elevated winds gradually declining to background levels, although this may take a few days as a weak influence from small CH83/- near the northern crown may arrive day 1 or day 2 (9-10th Mar).

Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3) throughout the period, with a chance of Active (Kp 4) intervals today or tomorrow under the declining influence of a HSS from one or two negative high speed streams, which are favoured for a slightly stronger geomagnetic response than otherwise expected as the vernal equinox approaches.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: BGS estimated Planetary K index (Kp).


Estimated Planetary K Index (Kp)
3 Hourly Kp
9 8 7 6 5 4 3 2 1 0
G5 G4 G3 G2 G1
02-03-2023 03-03-2023 04-03-2023 05-03-2023 06-03-2023 07-03-2023 08-03-2023 09-03-2023
BGS Scale: Quiet Unsettled Active Minor Storm Major Storm Severe Storm
NOAA Scale: G0 G0 G0 G1 G2-G3 G4

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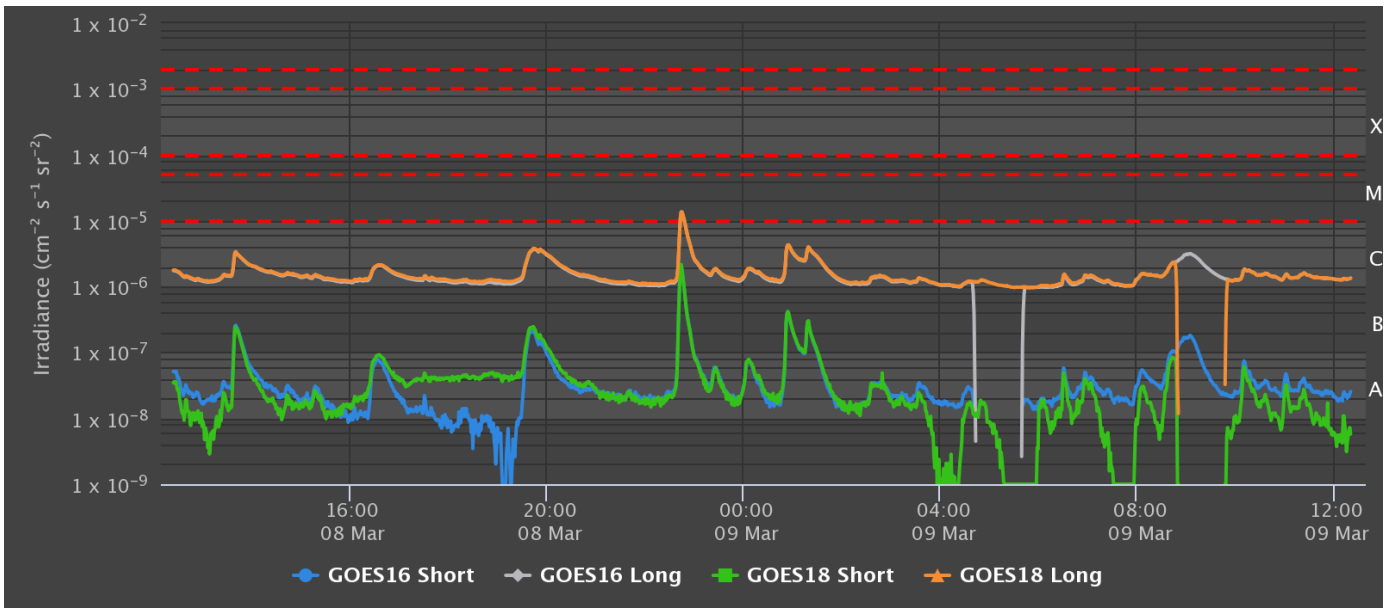
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate through the past 24 hours with an M1.4 flare from AR3245 at 08/2245 UTC.

There are nine numbered sunspot regions on the visible disc, and three small, weak and new and yet to be numbered regions that have just emerged onto the east limb. AR3242 remains a complex and elongated region. AR3245 is now the largest region on the visible disc, which briefly produced a 'delta spot' due to the slight increase in penumbra on the leading spot engulfing a small trailing spot, although the leading spot has now separated. The remaining numbered regions are all relatively simple and weak, and mostly stable or showing slight growth. Solar activity is forecast to be Low to Moderate, with a slight chance of isolated X-class flares throughout.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES X-Ray Flares



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. As AR3242 continues to rotate across the western hemisphere it brings an increasing risk of radiation storms, should it produce any larger flares. AR3245 will also make a small contribution despite its southeast location. Overall, the probabilities have been kept flat through the period with AR3242 and AR3245 forming the bulk of the risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux is at mostly high levels due to recent inputs from the coronal hole high speed stream. However, we have recently seen a brief suppressing of electrons due to the passing of a weak CME (which left the Sun on 06 Mar), early on day 1 (09 Mar) which has now passed. Electron flux is likely to return and remain above the high threshold through much of the period. There is also a risk of an increase in electron flux as the radiation belt is currently thought to be more significantly charged below GEO. As the high speed stream from coronal hole 81 continues to ease and the radiation belt relaxes and expands, the electron populations at lower orbits could enhance the GEO electron counts, although the potential connection of coronal hole 83 today or tomorrow could inhibit this relaxation.

Electron fluence is expected to remain above the Active (1e8 integrated pfu) threshold, with a very slight risk of exceeding the Very Active threshold, with an initially rising or level trend followed by a possible slow downward trend later in the period. In contrast MOSWOC REFM is forecasting a rapidly declining trend in the fluence through today, quickly falling below the Active threshold, which is not accepted.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	5	5	5

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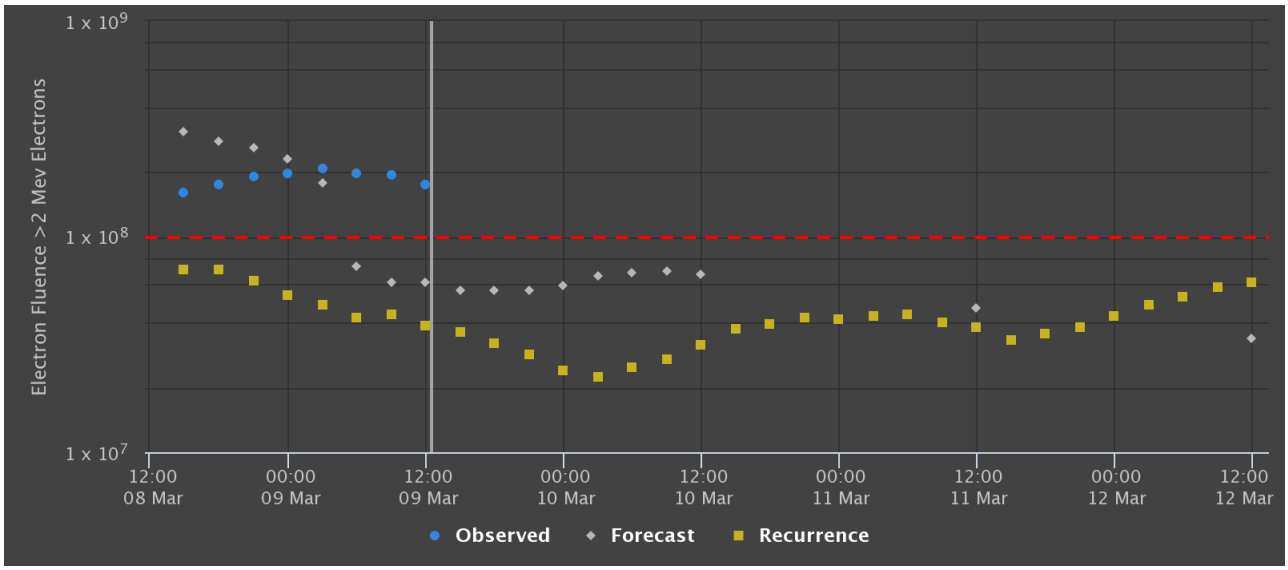
Figure 4: MOSWOC Electron Fluence – observations, forecast and recurrence



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